

COMMENTARY

The Agricultural Conservation Planning Framework: Opportunities and challenges in the eastern United States

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Assigned to Associate Editor Peter O'Brien.

Funding information

U.S. Department of Agriculture, Grant/Award Number: CEAP

Abstract

The Agriculture Conservation Planning Framework (ACPF) applies high-spatial resolution soils and topographic data, now available for many areas of the United States, to precisely locate opportunities for the placement of conservation practices in agricultural watersheds. Application of the ACPF, developed in midwestern landscapes, to watersheds in the eastern United States represents both opportunity and challenge to conservation planning. Based on experience in applying ACPF to eight watersheds in the eastern United States, from Vermont to North Carolina, we assess the toolbox's application in the eastern United States through the lens of strengths, weaknesses, opportunities, and threats (SWOT) analysis framework. We see a great future for the ACPF, but its adoption and utility require interaction with scientists and conservation planners familiar with the region to avoid misapplication and ensure appropriate adaptation and interpretation.

1 | INTRODUCTION

Agricultural nonpoint source pollution strategies now emphasize precision conservation by targeting appropriate conservation practices to watershed areas where cost-effective mitigation can be expected (Delgado & Berry, 2008; Osmond et al.,

2012). The Agricultural Conservation Planning Framework (ACPF) has emerged as a promising geospatial toolbox that uses high-resolution spatial data (1–3 m²) to identify potential locations for key conservation practices (Tomer et al., 2015). The ACPF was developed in Iowa, with initial plans for it to be used in the midwestern United States at the scale of HUC-12 watersheds (~40–160 km²). However, because it is based in large part on national engineering design standards and uses standard input data, the ACPF has been successfully run in Nebraska to Wisconsin to Ohio (Moorman et al., 2020; Porter et al., 2020), with discussions of wider

Abbreviations: ACPF, Agriculture Conservation Planning Framework; HUC, hydrologic unit; SWOT, strengths, weaknesses, opportunities, and threats; WASCOP, water and sediment control basin.

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application quickly growing. Given the momentum and growth, we feel it an appropriate time to reflect on our assessments adapting it to new and different landscapes.

Initial attempts have sought to apply the ACPF to the eastern United States, including to HUC-12 (12-digit scale hydrologic unit) watersheds in the Chesapeake Bay region (Chesapeake Conservancy, 2021). The ACPF has attracted attention from traditional conservation planners, watershed managers, program strategists, and researchers alike (Ranjan et al., 2020; Rundhaug et al., 2018). Its rule-based targeting of practices leverages newly available geospatial data to rapidly and precisely depict conservation options not provided by traditional planning approaches (Figure 1). In support of the ACPF's successful adaptation to the eastern United States, we reflect on its capabilities and limitations based on experience in testing it in watersheds in North Carolina, Pennsylvania, and Vermont. Here we use the increasingly common framework of strengths, weaknesses, opportunities, and threats (SWOT) analysis for our evaluation (Table 1). A common tool in the business sector, a SWOT matrix approach helps evaluate both internal and external factors for potential success and viability. We recognize the term "threats" can be interpreted many different ways; our use of this category in a SWOT analysis is to highlight areas of challenge related to ACPF application.

Significantly different expectations of planning tools across regions and states make the successful adoption of any conservation planning framework challenging. End users will want local information, both biophysical and socioeconomic aspects, incorporated for successfully siting conservation practices. Differences in hydrology and agriculture are impor-

Core Ideas

- The Agriculture Conservation Planning Framework (ACPF) is a spatial tool not yet well tested in the eastern USA.
- Parts of the toolbox work quite well in eastern U.S. landscapes.
- Other parts of the toolbox leave questions for application and interpretation.

tant considerations when adapting and assessing the ACPF toolbox approach to eastern U.S. landscapes. For example, with regard to hydrology, there are fundamental differences in dominant streamflow generation mechanisms between regions. There is higher prevalence of tile drainage in many midwestern watersheds (Vidon et al., 2012). For instance, in the Appalachian provinces of the Chesapeake Bay region, agriculture is often located in carbonate valleys under-drained by karst features that more directly connect farm fields to river networks (Ator et al., 2019), potentially short-circuiting conservation practices. Additionally, field and agronomic conditions in many areas of the eastern United States may pose a challenge to the ACPF's application to eastern watersheds, particularly when differences are ignored. The ACPF is principally focused on annual cropping systems, consistent with the dominance of corn (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] in the midwestern watersheds where it has

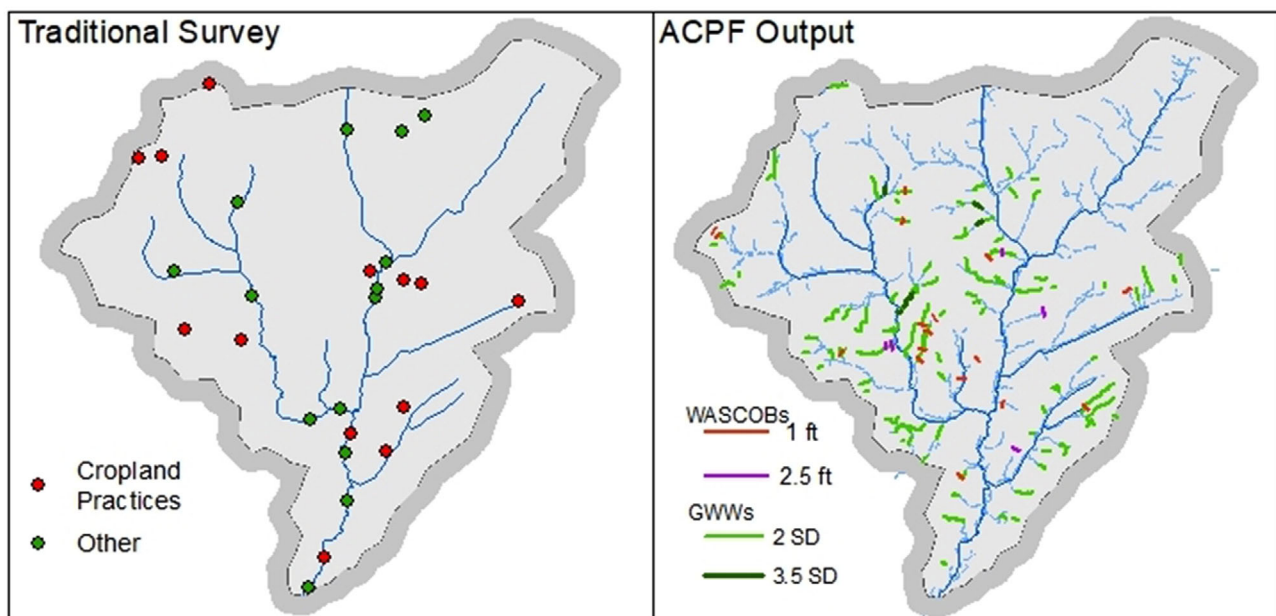


FIGURE 1 Contrasting watershed planning maps from traditional, expert-based assessment (A) and Agricultural Conservation Planning Framework (ACPF) assessment (B) of row-crop in field practices of water and sediment control basins (WASCOBs) and grassed waterways (GWWs) for a small watershed within the Susquehanna River basin

TABLE 1 Strengths, weaknesses, opportunities, and threats (SWOT) assessment for Agricultural Conservation Planning Framework (ACPF) application to the East Coast

Strengths	Weaknesses
Objective (even if biased)	Subset of practices included, none on soil health or nutrient management
Expedient	Requires time and expertise
Combines flowpaths, crop data, and field shape	No accounting of existing practices
Visual and could help with outreach/engagement	Only as good as user input and judgment/expertise
Large institutions showing interest	
Opportunities	Threats
Outreach and implementation coordination	Precision reduces anonymity
Leverage new LiDAR, spatial data	Misinterpretation, especially if not carefully edited
Find more and new options unknown to planners	Confusion if different data, processing, and input parameters yield different results
Central point of collaboration for conservation groups	

been applied. However, many areas of the eastern United States include agricultural fields that have more diverse crops, are smaller in size, and are dissected by more complex topography and soils. In addition, perennial forages and pastures are common in parts of the eastern United States, requiring different conservation emphases than those prioritized for annual crops.

2 | STRENGTHS

From a watershed management perspective, there are key similarities between the watersheds in the Mississippi River basin where the ACPF has historically been applied and the East Coast test watersheds from which our inferences derive. The ACPF identifies practices that have established benefits to soil conservation and nutrient pollution mitigation, priorities of watershed programs in the U.S. Midwest and East alike. Most of the practices included in the ACPF are sited using terrain analysis that adheres to standard engineering practices. In this regard, the tool should be extensible to other geographies without issue. For instance, stream power index, the product of upslope accumulated area and tangent of local slope, is used to site grassed waterways and has been the subject of research across a broad range of geographies (Chow et al., 1999; Fiener & Auerswald, 2003). Further, the ACPF is well documented with substantial training opportunities, and good support from USDA, all critical ingredients to the extension of the tool outside of areas where it was originally developed.

The ACPF toolbox focuses mostly on structural and vegetative practices in row cropped fields and typically produces a large set of potential locations for conservation practice placement. This stands in stark contrast to traditional watershed planning approaches that can focus on a wide variety of issues, including stream restoration, urban stormwater, and those that prioritize nutrient management (Figure 1). Furthermore, tra-

ditional watershed management plans are rooted in deep connections with watershed planners and farmers. The opportunities identified often arise from existing relationships with landowners and farmers. While usually identifying a smaller number of opportunities, traditional management plans do not typically provide a precise, recommended location that optimally sites BMPs or gives willing landowners a better sense of the extent and location of conservation practices (Figure 1A). At the same time, even within the context of fields, the ACPF toolbox produces immense amounts of geospatial data and field-specific information across the entire watershed. These outputs could easily be used for additional watershed planning purposes beyond those specifically included in the toolbox. For instance, calculations from the field runoff risk or riparian characterization tools could serve as proxies for potential locations for edge-of-field or near-stream practices like bioreactors and gypsum curtains in non-tile drained fields.

3 | WEAKNESSES

There are potential limitations to successful application of the ACPF outside of its original context. Among the first we have encountered is that some of the conservation practices included in the ACPF are either unfamiliar to local planners or impractical in eastern agricultural settings. For example, the ACPF identifies opportunities for contour buffer strips, which because of their emerging role in eastern conservation planning has not been established, or field sizes are so small that they are impractical. In other cases, better established practices are prioritized by the ACPF (e.g., water and sediment control basins (WASCOBs) and nutrient removal wetlands), but they may not be prioritized by conservation planners. For instance, WASCOBs are often too intrusive to recommend for in-field conservation practices in the small fields of eastern watersheds where farm ponds, which are similar to

WASCOBs, are the preferred practice. In areas dominated by perennial forages (pasture and hay fields), a primary emphasis in current conservation planning is improving soil health, which is standard assumption in the ACPF. More broadly, the ACPF itself does not account for existing practices, which without proper context can be interpreted negatively by planners or landowners who have spent considerable time and money on conservation.

Even users of the ACPF have different philosophies for application: a spatially intensive focus where a single or small number of HUC-12s are the focus vs. a spatially extensive focus where an entire river basin with 1,000s of HUC-12s is the goal. This necessarily changes the approach conservation planners take to dial in parameters for contrasting landscapes. Inherent tradeoffs are associated with the quality of application and control of the outputs when several HUCs are considered vs. thousands. Large efforts are underway in the Mississippi drainage, where stakeholders are collectively working to reduce nitrogen losses that impair the Gulf of Mexico (ACPF in Action, 2021). In the east, the Chesapeake Bay Program is testing ACPF with uniform data and default parameters across the watershed. Consequently, outputs will vary across different physiographic regions, ranging from low relief terrain in the Coastal Plain to the rolling hills of the Piedmont, to the steeper slopes of the Ridge and Valley. Even in a single HUC-12, consideration must be provided for differences in output for some conservation practices like WASCOBs and grassed waterways (Figure 1B).

4 | OPPORTUNITIES

The ACPF presents a host of opportunities to expand and develop new conservation partnerships and approaches. The tool provides a detailed spatial approach that provides planners with consistent and complete options for watershed-scale planning. As high-resolution LiDAR becomes increasingly available, there are greater opportunities to assess resource concerns consistently across HUC-12 watersheds and beyond using the ACPF. The breadth of output enables planners to identify and assess more and newer opportunities in conservation planning and in the placement of practices. The ACPF also provides new opportunities to integrate with emerging research. For instance, researchers, planners, and extension agents are collaborating with producers to understand optimal conservation practice maintenance and resilience in a changing climate. As weather events become more extreme in the northeastern United States compared with the Midwest (Chien et al., 2013; Demaria et al., 2016), so too will the importance of landscape-focused conservation efforts in mitigating these high-impact events. Regardless, and in any region where the ACPF is considered, research and empirical evidence should support the siting and selection of conservation practices.

The ACPF has the potential to serve as a graphical focal point for collaborative conservation planning, bringing together a diverse set of organizations and individuals in watershed planning (Lewandowski et al., 2020; Ranjan et al., 2019). While the ACPF itself is not a comprehensive conservation toolkit, it provides consistency through rule sets and offers insights into an expanded set of conservation practices through easily executed routines, which consider hydro-morphic processes that affect nearly all forms of watershed planning. For instance, ACPF output could serve part of the menu of conservation measures options to address water quality goals like a total maximum daily load or watershed planning goals like enhanced wildlife and aquatic life. When combined with priorities for soil health and nutrient management, the ACPF could serve as a scenario generator for planners to consider the level of effort required to meet watershed planning goals (McLellan et al., 2018; Srinivas et al., 2020). To this end, the tool itself is open source and therefore could be adapted and extended for local conditions and practices.

5 | THREATS

A principal threat for a new tool like the ACPF is the extent to which it complements vs. conflicts with existing planning tools (e.g., Conservation Assessment and Ranking Tool [CART] or state-specific runoff risk assessment tools). The increasing use of the ACPF by a broader array of organizations, with a diversity of goals and approaches, could complicate the perceptions of output and the tool's utility. Even when using the exact stream network, applying the tool with different parameters can produce considerably different outcomes in the number and location of some practices like WASCOBs and grassed waterways. Continual effort is needed to test optimal siting parameters in different agricultural regions and physiographic provinces (Respass & Duncan, 2021). Watershed managers should not simply add up the total number of potential placement locations to prioritize HUC-12 watersheds with variable soils, topography, and agriculture. Beyond that, a holistic systems perspective is necessary to evaluate tradeoffs and into which watershed the next marginal conservation dollar should be spent. Investing in understanding how different scenarios of possible management options would not only improve watershed scale water quality but also balance placement options with farm economics and ecosystem services. Our initial work across North Carolina, Pennsylvania, and Vermont suggests that different parameters for conservation practices can stack WASCOBs and grassed waterways on farms with more sloped fields draining fields that are higher upslope. For instance, would it be realistic or equitable for watershed managers to assume one producer with a 40-acre (~16 ha) farm should use five WASCOBs while others do not have to use any? What if that same upslope producer with

five WASCOBs sited on their field already conducts rigorous nutrient management and soil health practices that are not taken into account in the ACPF?

The locational approach of the ACPF necessarily can be tremendously helpful for optimizing practice placement; however, balancing the benefits of precision conservation with privacy concerns will be extremely important. Accounting for existing conservation practices, some of which required substantial investments from landowners and farmers will be important. There are programmatic histories across states in terms of which practices are used and preferred (Dodd & Sharpley, 2016). Customizing the ACPF to meet these needs by adding new practices or leveraging it by using outputs (intermediate or final) as proxies as discussed above to site a broader set of practices could be useful.

6 | CONCLUSION

There are many potential use-cases for the ACPF in the eastern United States, but its applicability is not universal. Understanding its limitations is necessary to avoid the potential for inappropriate application and misinterpretation of outputs that have always been acknowledged by its developers. Communicating to stakeholders the intentions of the tool will help set expectations. To make it more successful, we need to rally the broader conservation community in order to more fully account for threats and find ways to have synergistic outputs from different groups. A single systematic approach could be undermined if local conditions are not acknowledged, or local partners are not engaged. Engaging ACPF technicians, watershed planners, producers, and landowners to co-develop precision watershed plans is critical for success. As the use of the ACPF increases, especially across multiple organizations, one of the largest challenges is communicating to end users the variability in outputs. Additionally, users, researchers, and planners could benefit from co-producing knowledge with producers to find the most effective conservation solutions. When the ACPF is implemented appropriately, it can provide objective and transparent planning options with reasonable placement of conservation practices, essential to navigating discussions around conservation adoption.

AUTHOR CONTRIBUTIONS

Jonathan M. Duncan: Conceptualization; Formal analysis; Funding acquisition; Project administration; Visualization; Writing-original draft; Writing-review & editing. Zachary Respass: Formal analysis; Methodology; Writing-review & editing. William Ryan: Visualization; Writing-review & editing. Robert Austin: Formal analysis; Methodology; Writing-review & editing. Matthew Royer; Data curation; Writing-review & editing. Deanna Osmond: Funding acquisition; Project administration; Writing-review & editing;

Peter Kleinman: Funding acquisition; Project administration; Writing-original draft; Writing-review & editing.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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How to cite this article: Duncan, J.M., Respass, Z., Ryan, W., Austin, R., Royer, M., Osmond, D., & Kleinman, P. The Agricultural Conservation Planning Framework: Opportunities and challenges in the eastern United States. *Agric Environ Lett*, 2021;6:e20054. <https://doi.org/10.1002/ael2.20054>